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(54) Method for realising insulation around a conductive bar

(57) The method for realising an insulation (5) around a conductive bar (1) comprises wrapping an insulating tape (2) around the conductive bar (1), enclosing it into a flexible container (4), applying a vacuum, impregnating the insulating tape (2) with an impregnating resin, curing the impregnating resin and removing the conductive bar (1) with the insulation (5) around it from the flexible container (4). In addition, together with the insulating tape (2), also an impregnating tape (3) made of said impregnating resin is wrapped around the conductive bar (1). In order to impregnate, the impregnating tape (3) is melted.

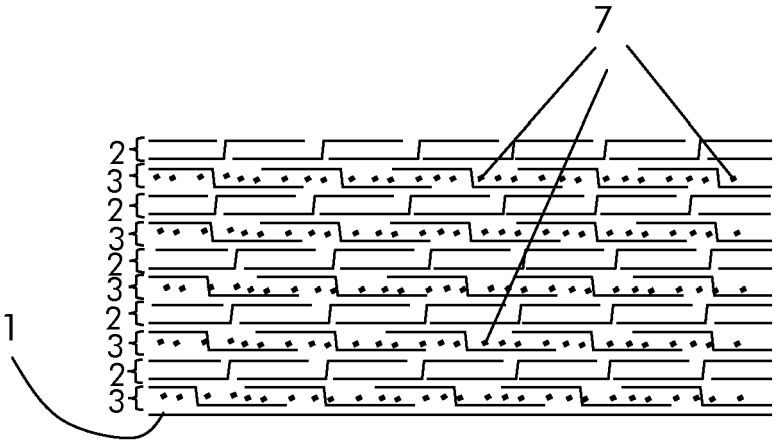

Fig. 7

EP 2 339 723 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a method for realising insulation around a conductive bar.

[0002] In particular the present invention refers to conductive bars made of interwoven conductive strands (Roebel bars) having an insulating mica tape wrapped around them for use in high voltage large electric machines such as large generators.

BACKGROUND OF THE INVENTION

[0003] Stator bars of large electric generators have a conductive bar (green bar) made of a plurality of interwoven conductors each provided with an insulating layer.

[0004] The conductive bar or green bar is provided with main insulation that is wrapped around it.

[0005] The main insulation is manufactured by wrapping one or typically more than one layer of a mica tape around the conductive bar.

[0006] The mica tape is thus impregnated with a resin that is then cured, in order to realise compact and stiff insulation around the conductive bar.

[0007] Usually, in order to impregnate the mica tape, either the Resin-Rich process or the VPI process are used; in the following these processes are briefly described.

RESIN-RICH PROCESS

[0008] According to the Resin-Rich process, a mica tape having a backing layer and a mica layer pre-impregnated with a B stage impregnating resin in a large amount is used.

[0009] In particular, the mica tape is first wrapped around the conductive bar and then it is pressed, to make the excess of B stage impregnating resin contained within the mica tape to be expelled therefrom.

[0010] Thus the B stage resin is cured, in order to transform the B stage resin in A stage resin that has the mechanical and electrical properties required.

[0011] Resin-Rich process proved to have these drawbacks:

- Pre-impregnated mica tapes for Resin Rich impregnation are very expensive, thus also the conductive bars whose mica tape is impregnated this way are consequently expensive;
- Separate containers for warming up the pre-impregnated mica tape and curing the resin are required;
- Void filling is not optimal, since some voids are closed before impregnation by the adhesive tape.

VPI PROCESS

[0012] In the VPI process (or its equivalent TVPI; in the following reference to the VPI will be made) a mica tape having only a backing layer and a mica layer is used (with a minimum amount of resin for bounding the mica and the backing layer together).

[0013] During manufacturing, the mica tape is wrapped around the conductive bar realising one or typically more than one mica tape layer.

[0014] Afterwards the conductive bar with the dry mica tape wrapped around it is introduced into a tank wherein vacuum is applied in order to extract all gases (such as air) from the mica tape; then impregnating resin is introduced into the tank under pressure to impregnate the mica tape.

[0015] Also the VPI process has a number of drawbacks; in particular:

- VPI process requires a pressure resistant container that is very expensive;
- Impregnation depends on the permeability of the mica tape; usually very thick mica tape layers are difficult to be impregnated;
- In case the mica tape contains filler, impregnation is further hindered and in addition the filler may be removed during impregnation.

SUMMARY OF THE INVENTION

[0016] The technical aim of the present invention is therefore to provide a method by which the said problems of the known art are eliminated.

[0017] Within the scope of this technical aim, an aspect of the invention is to provide a method that is cheaper than traditional Resin-Rich and VPI methods.

[0018] Another aspect of the invention is to provide a method that allows an optimal impregnation, also in case the mica tape wrapped around the conductive bar is very thick and contains filler.

[0019] A further aspect of the invention is to provide a method by which high rate void filling is achieved and filler removal during impregnation is prevented or at least largely reduced.

[0020] The technical aim, together with these and further aspects, are attained according to the invention by providing a method in accordance with the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Further characteristics and advantages of the invention will be more apparent from the description of a preferred but non-exclusive embodiment of the insulating mica tape and method according to the invention, illustrated by way of non-limiting example in the accompanying drawings, in which:

Figures 1-6 show different stages of the method in an embodiment of the invention;

Figures 3a and 4a shows further stages of the meth-

od of figures 1-6; and

Figures 7 and 8 show two different embodiments of mica tape and impregnating tape wrapped around a conductive bar.

DETAILED DESCRIPTION OF THE INVENTION

[0022] With reference to the figures, these show a method for realising insulation around a conductive bar.

[0023] The conductive bar 1 is a stator bar of a large electric machine and thus has a plurality of interwoven conductive strands (Roebel bar); the figures show only a portion of the bar.

[0024] The method comprises wrapping an insulating tape 2 around the conductive bar (figure 1) typically with 50% overlapping.

[0025] The insulating tape is a mica tape made of a mica paper bounded to a backing layer; for example a mica tape typically used in the VPI or TVPI process may be used.

[0026] In addition, together with the insulating tape 2, also an impregnating tape 3 (figure 2) made of an impregnating resin is wrapped around the conductive bar 1.

[0027] The impregnating tape 3 comprises a B stage impregnating resin such as a bisphenol A epoxy resin or a novolac epoxy resin and preferably it is also provided with a supporting material such as a carbon fibre net to increase its mechanical properties. Overlapping of the impregnating tape can be chosen according to the required impregnating resin amount.

[0028] The insulating tape 2 and the impregnating tape 3 are wrapped around the conductive bar 1 such that at least a layer of the impregnating tape and at least a layer of insulating tape are alternatively formed.

[0029] In this respect, figure 7 shows an example in which one layer of the insulating tape 2 and one layer of the impregnating tape 3 are alternatively wrapped around the conductive bar 1.

[0030] In addition, figure 7 also shows that the inner layer directly in contact with the conductive bar 1 is made of the impregnating tape 3; in contrast the outer layer (i.e. the last layer around which no further layer is wrapped) is made of the insulating tape 2.

[0031] Figure 8 shows a further example in which a plurality of layers of insulating tape 2 and one layer of impregnating tape 3 are alternatively wrapped around the conductive bar 1.

[0032] Also in this example the inner layer is made of an impregnating tape 3 and the outer layer is made of the insulating tape 2.

[0033] Naturally in different embodiments the inner layer may also be made of an insulating tape and the outer layer may be made of an impregnating tape.

[0034] Afterwards, the conductive bar 1 with the insulating tapes 2 and the impregnating tapes 3 wrapped around it is enclosed into a flexible container 4 (figure 3).

[0035] The flexible container 4 has the same features as the flexible container described in US 6,840,749.

[0036] Thus a vacuum is applied in order to extract the gases contained in the flexible container and, in particular, in the insulating tape, to achieve a high quality impregnation.

[0037] In particular, when the vacuum is applied and the gas is extracted, a pressure between 0.1-10 mbar is achieved in the flexible container 4.

[0038] Thus the insulating tape 2 is impregnated with the impregnating resin; in this respect the impregnating tape 3 wrapped together with the insulating tape 2 is melted (figure 4), such that the impregnating resin moves towards the insulating tape 2 and impregnates it.

[0039] Afterwards the impregnating resin is cured (figure 5) and thus the conductive bar 1 with the insulation 5 around it is removed from the flexible container 4 (figure 6).

[0040] In order to melt the impregnating tape without starting the curing of the impregnating resin in a too early stage (figure 4), the impregnating tape 3 is warmed up to a first temperature lower than the curing temperature of the impregnating resin.

[0041] Figure 3a shows a possible shaping stage that could be performed after the conductive bar 1 with the insulating tape 2 and the impregnating tape 3 wrapped around it has been inserted into the flexible container 4 and before impregnation.

[0042] Shaping is achieved by pressing; for example a metal plate 6 is pressed against each of the sides of the conductive bar 1 (having the insulating tape 2 and the impregnating tape 3).

[0043] After pressing, one or more metal plates 6 can be moved away from the conductive bar 1 and the flexible container 4 may be stretched, removing any crinkle.

[0044] In addition, figure 4a shows a further possible stage, in which the insulating tape 2 is pressed also during impregnation.

[0045] Also in this case pressing is achieved via the metal plates 6 pressed against each of the sides of the conductive bar 1.

[0046] In this case, advantageously pressing begins after impregnation has already started.

[0047] The method of the invention lets a short impregnating time be achieved. In fact, since the impregnating tape (that contains the impregnating resin) is wrapped in alternate layers with the insulating tape to be impregnated, during impregnation the resin has only to impregnate a very limited thickness of the insulating tape.

[0048] In addition, as known, usually also filler is included in the insulation 5 in order to improve the electrical and/or the thermo-conductive properties of the insulation 5.

[0049] In this respect the impregnating tape 3 that constitutes one or more of the impregnating tape layers may contain filler 7 (figure 7).

[0050] The filler 7 is known to hinder impregnation and to make impregnation very slow.

[0051] Advantageously, as already explained, because of the limited insulating tape thickness to be im-

pregnated, according to the method of the invention, also in cases in which the filler 7 is provided a quick impregnation is achieved.

[0052] In addition, filler removal is prevented, because the path, through which the impregnating resin has to go through, is very small.

[0053] Naturally the features described may be independently provided from one another.

[0054] The impregnating mica tape and the method conceived in this manner are susceptible to numerous modifications and variants, all falling within the scope of the inventive concept; moreover all details can be replaced by technically equivalent elements.

[0055] In practice the materials used and the dimensions can be chosen at will according to requirements and to the state of the art.

REFERENCE NUMBERS

[0056]

1 conductive bar

2 insulating tape

3 impregnating tape

4 flexible container

5 insulation

6 metal plates

7 filler

Claims

1. Method for realising insulation (5) around a conductive bar (1) comprising wrapping an insulating tape (2) around the conductive bar (1), enclosing it into a flexible container (4), applying a vacuum, impregnating the insulating tape (2) with an impregnating resin, curing the impregnating resin and removing the conductive bar (1) with the insulation (5) around it from the flexible container (4), **characterised in that**, together with the insulating tape (2), also an impregnating tape (3) made of said impregnating resin is wrapped around the conductive bar (1), and **in that**, in order to impregnate, the impregnating tape (3) is melted.

2. Method according to claim 1, **characterised by** shaping the insulating tape (2) and the impregnating tape (3) before impregnation.

3. Method according to claim 2, **characterised in that** shaping is achieved by pressing.

4. Method according to claim 1, **characterised in that** when vacuum is applied, a pressure between 0.1-10 mbar is achieved in the flexible container.

5. Method according to claim 1, **characterised by** pressing the insulating tape (2) during impregnation.

6. Method according to claim 5, **characterised in that** pressing during impregnation begins after impregnation has already started.

7. Method according to claim 1, **characterised in that**, in order to melt, the impregnating tape (2) is warmed up to a first temperature lower than the curing temperature.

8. Method according to claim 1, **characterised in that** at least a layer of the impregnating tape (2) and at least a layer of insulating tape (3) are alternatively wrapped around the conductive bar (1).

9. Method according to claim 8, **characterised in that** an inner layer directly in contact with the conductive bar (1) is made of the impregnating tape (3).

10. Method according to claim 8, **characterised in that** an outer layer is made of an insulating tape (2).

11. Method according to claim 1, **characterised in that** the impregnating tape of at least one impregnating tape layer contains filler (7).

12. Method according to claim 1, **characterised in that** the insulating tape (2) is a mica tape made of a mica paper bounded to a backing layer.

13. Method according to claim 1, **characterised in that** the impregnating tape (3) comprises a B stage impregnating resin.

14. Method according to claim 13, **characterised in that** the impregnating tape (3) comprises a supporting material.

15. Method according to claim 3, **characterised in that** the conductive bar (1) has a plurality of interwoven conductive strands.

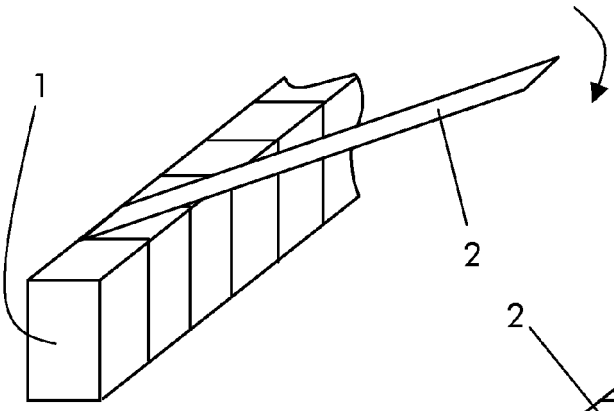

Fig. 1

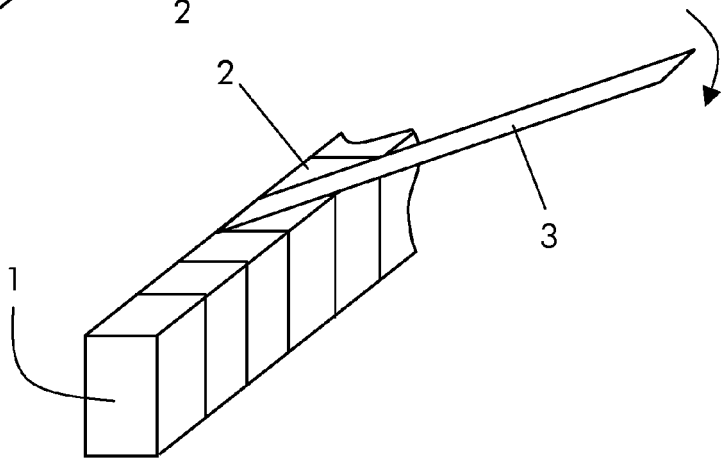

Fig. 2

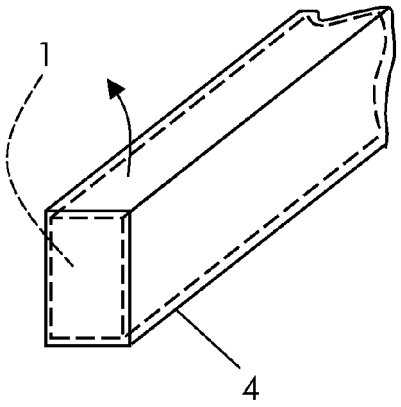

Fig. 3

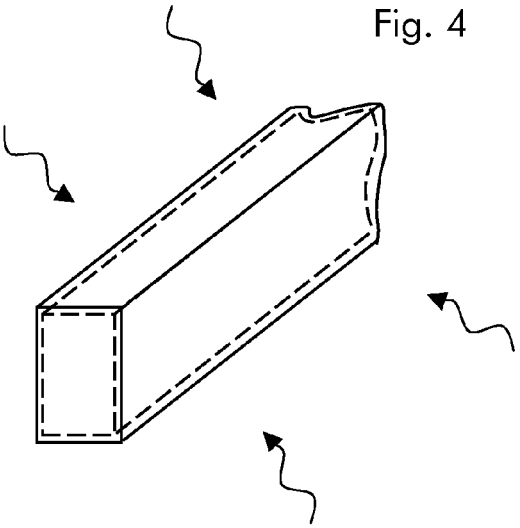

Fig. 4

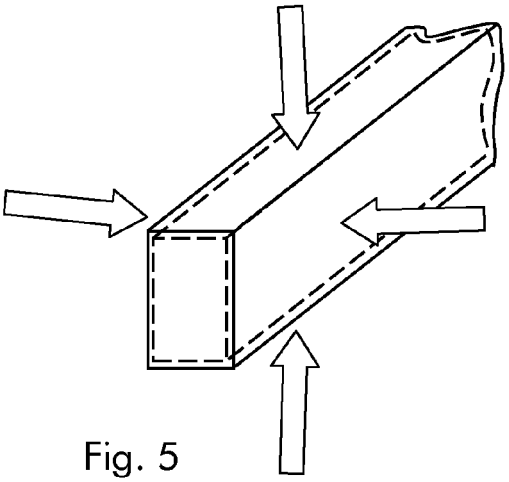

Fig. 5

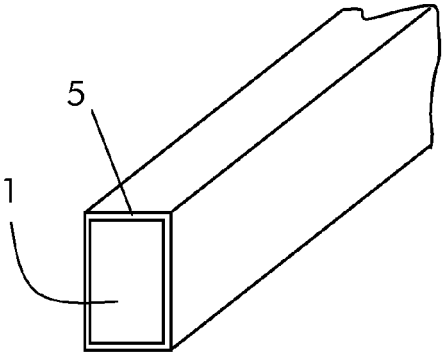

Fig. 6

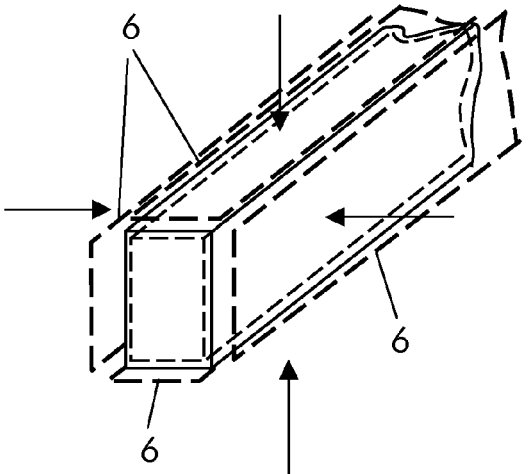

Fig. 3a

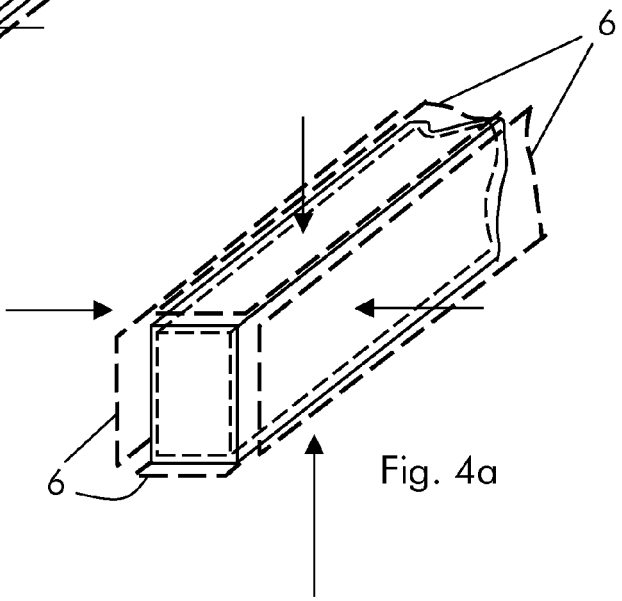

Fig. 4a

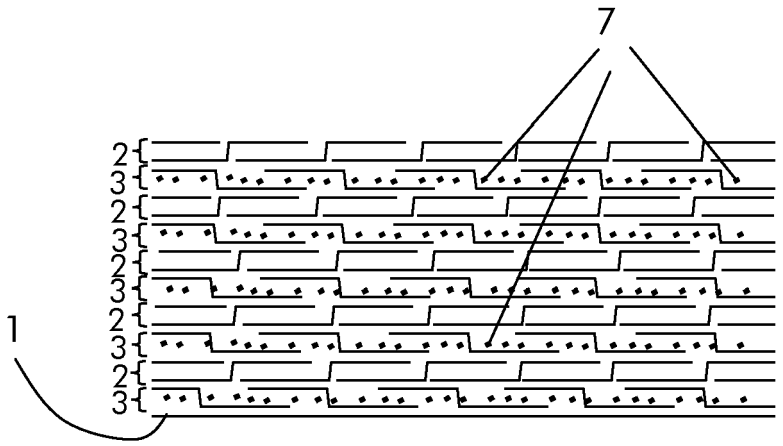

Fig. 7

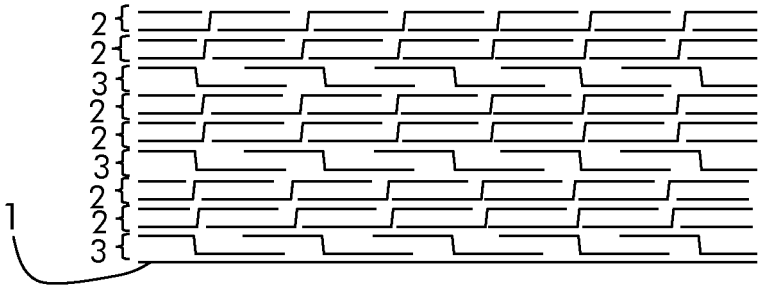

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 09 18 0299

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 05 328650 A (HITACHI LTD) 10 December 1993 (1993-12-10) * paragraphs [0004], [0007], [0010], [0019] - [0023], [0032]; claim 1; figures * -----	1-15	INV. H02K15/12
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TECHNICAL FIELDS SEARCHED (IPC)

H02K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 May 2010	Mayer-Martin, E

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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